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USE OF PLANT INDICATORS AS AN INDEX TO SITE QUALITY[1]

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IN ANY DISCUSSION of site evaluation we need to know first what the forester means by the term "site", and the function site serves in the field of forestry. The term may mean different things to different people. According to the Society of American Foresters' Terminology, site is:

> ". . . an area considered as to its ecological factors with reference to capacity to produce forests or other vegetation; the combination of biotic, climatic, and soil conditions of an area."

In essence this means a piece of forest land whose profile includes not only the soil with its underlying substratum of rock but also the atmosphere superimposed on it.

Operating on these various strata are a series of environmental factors whose combined action determines the form and structure of the vegetation. Some of these factors, such as humidity, soil moisture, solar radiation, and temperature influence vegetation directly. Others, such as altitude, degree and direction of slope, and the flora and fauna of the soil, do so indirectly through their action on the direct factors. Thus, site is the interaction of many varying factors. It is extremely complex, and it defies attempts to prescribe precise boundaries to its component parts.

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[1] A PAPER PRESENTED AT A MEETING OF THE NEW ENGLAND SECTION OF THE SOCIETY OF AMERICAN FORESTERS AT BOSTON, MASS., IN MARCH 1954.

Sites in which habitat factors combine in such a way as to create uniform environments may be regarded as identical and, therefore, endowed with the same capacity for timber production. Identical sites may occur in distinctly different climatic regions, but in so doing they occupy different soils or topography by way of compensation. Site factors vary in their duration and intensity; consequently they give rise to sites that vary widely in yield capacity.

The Need For Site-Quality Guides

Knowledge of the capacity of forest land for growing timber is basic to all forms of timber-resource management. Thus, there is need for site-evaluation systems that indicate the productive capacity of any area of forest land in terms of definite species or group of species. Ultimately foresters must be able to predict the kind, yield, and quality of timber that can be produced from lands of varying productivity.

The Plant-Indicator Concept

Since site quality--or productive capacity--is directly related to site factors, determination of site quality necessitates evaluation of site factors. A number of methods for accomplishing this have been developed and are currently in use. One method in which plant communities are used to identify site is receiving increased attention. This system is based on the thesis that specific plants (indicator plants) forming a part of the minor vegetation in the forest are associated with soil quality and natural succession. Since vegetation is the product of all the site factors operating on a site, it should provide a much sounder basis for site classification than would a single site factor or group of site factors.

The concept of plant indicators recognizes that plant communities are distinct entities developed and arranged in accordance with definite biological laws; they are not mere aggregations of plants brought together by chance. Such plant communities are well differentiated and are very constant for the same site type. Even though the forest is subjected to disturbance, plant communities quickly come back to equilibrium.

Using the plant-indicator principle, it is possible to develop a classification of ground-vegetation types that

are indicative of site-quality classes. Each plant community is characterized by one or several plants that are biologically dominant. It is true that specific plant species may be common to several plant communities, but in one of them it is hardier and better able to withstand competition than its associates. It is this that provides the key to recognition of various plant communities.

Origin And Spread Of The Plant-Indicator Concept

The plant-indicator system was developed by Cajander in the early part of the twentieth century. It has a strong following in Europe, particularly in the northern countries. Attempts to apply the system to the forests of North America have met with varying degrees of success. In the northern United States and Canada, where plant communities are relatively simple, considerable progress has been made. Farther south, where plant communities are considerably more complex and forest disturbance has been rampant and radical, results have been less satisfactory.

Interest in the system in this country was stimulated by the Finnish forester Illvessalo, following his site-type classification work in Canada and the United States in 1927. Studies by the Northeastern Station of the significance of minor vegetation in the spruce-fir and northern hardwood types were started as early as 1924. Similar studies in the white pine type were undertaken on the Fox Demonstration Forest. Of particular note is Heimburger's work in the Adirondack region in 1932 and 1933. In recent years the Dominion Forest Service and other Canadian research agencies have contributed liberally to the literature on site-type classification. Fairly complete indicator types have been determined for the major spruce-fir types of eastern North America[2], and considerable progress is being made in the conifer types in the Northwest.

Developing A Plant-Indicator Classification

To evolve such a classification for any given forest region calls for the analysis of large quantities of vegetation data. Normally these data are obtained from milacre

[2]See 'The ecology and silviculture of spruce-fir forests of eastern North America', by Marinus Westveld, in Jour. Forestry 51: 422-430. 1953.

transects established in widely distributed, representative stands in each of the major forest types of the region in question. In selecting sample stands, climax or near-climax conditions should be sought. On each milacre quadrat the frequency of each ground-cover species is recorded. Then the vegetation data from all transects within a given forest type are summarized and analyzed to determine the species that show a strong correlation with other species. These species must be common enough to be of practical use. They are considered indicator plants significant of site quality.

For example, the Viburnum-Oxalis plant community characteristic of the red spruce-sugar maple-beech type is indicative of higher site quality than the Oxalis-Cornus association that characterizes the red spruce-yellow birch type. The Oxalis-Cornus association, in turn, represents a higher fertility level than sites supporting the Cornus-Maianthemum association that is characteristic of the red spruce-balsam fir type.

Techniques Of Ground-Vegetation Mapping

Once a plant-community classification for a forest region has been evolved, the task of classifying the forest into ground-vegetation types parallels closely the techniques employed in forest-type mapping. In fact ground-vegetation type-mapping, if possible, should be conducted in conjunction with the regular forest survey by assigning to the survey crew a skilled vegetation mapper.

Mapping can best be accomplished through the standardized system of parallel traverse lines at sufficient frequency to cover all variations in vegetation. At regular intervals along these lines the mapper determines the ground-vegetation type and records it on his base map, sketching in the type boundaries as he proceeds. The mapper should be an experienced ecologist familiar with both the primary and subordinate vegetation of the region. He must also have a discerning eye for forest-type trends and succession.

Value And Application Of The Plant-Indicator Concept

A ground-vegetation type map is the practical equivalent of a type-management map. Therein lies its real value, for ground-vegetation types can be translated directly into site potentialities.

Not only do vegetation types provide the index to timber yield potentials, but they also provide a sound basis for proper orientation of silvicultural goals. Knowing where the most favorable site types occur for the growth of specific tree species is one of the principal requisites of profitable timber production. For example, the ground-vegetation type equivalent of the red spruce-yellow birch type is Oxalis-Cornus. Even should the present tree cover, owing to past cutting practices, consist mainly of hardwoods, the presence of Oxalis acetosella and Cornus canadensis, key indicators of softwood sites when they occur in combination, warns the forester against managing primarily for hardwoods. Here silviculture should be aimed at reestablishing the normal softwood representation.

From the silviculturist's point of view, the principal value of a site-type classification lies in its potentialities for identifying forest sites that are biologically of the same value. The reaction of biologically equivalent sites to long-term application of a given intensity of forest practice should be reasonably uniform. Thus an accurately developed site-type classification enables the forest manager to delineate his property into zones requiring uniform silvicultural treatment. From the forest manager's standpoint, only the extent to which the site-type classification successfully portrays biologically equivalent sites justifies its application.

Although my personal experience with the plant-indicator concept as applied to the spruce-fir region has convinced me of its value, I would be the last to contend that it is the panacea for all our site-evaluation problems. Radically disturbed areas, even in the northern forest region, will defy classification through this system for an indeterminate period. The system is not infallible. Because it works successfully in our northern forests it does not follow that it can be applied with equal success in the central and southern regions.

I seriously doubt that we shall ever evolve a single method that will be all-sufficient. The problem resolves itself into selecting the system which most nearly meets the requirements and peculiarities of the problem on hand. Personally, I feel that plant indicators used in conjunction with other site manifestations such as tree height, tree associations, soils, and land forms will aid in a more accurate delineation of forest sites. We should welcome any new significant factor that will enable the forester to attain this objective.
